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# SMART AQUARIUM BASED CONTROLLING WATER AND FISH FEED FOR BETTA FISH CULTIVATION

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**ABSTRACT**

Betta Fish is a type of freshwater fish that is popular for cultivation. Failure in breeding Betta Fish often occurs due to water quality not being maintained. This study aims to create a water and feed quality control system. The parameters tested were dissolved solids (TDS), pH, and water level. The method of controlling the quality of water and feed was carried out by testing three water samples, namely: 1,200 ml of PDAM water (T1), 1,200 ml of methylene blue water (T2), and 1,200 ml of Terminalia Catappa L. (TCL) extract water (T3). From the testing of the three types of water, the error of dissolved solid particles in T1 was 19.89%, T2 was 5.58%, and T3 was 4.44%. Average pH at T1: 6.91, T2: 7.2, T3: 7.03. In addition, the average feed output of 7-8 pellets with feed servo opening was 450. From the test results, the developed water and feed quality control system can be used to help increase the productivity of betta fish.

**Keywords:** betta fish, water quality control, feed quality control, IoT.

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## INTRODUCTION

Cultivation of ornamental fish is currently starting to grow rapidly helping to increase the economic and recreational value of agriculture (Saeed *et al.*, 2022). Aquaculture is the cultivation of aquatic organisms including fish, mollusks, crustaceans and aquatic plants (Tumwesigye *et al.*, 2022). In the current cultivation of freshwater ornamental fish, the high demand for fish by the community are including Arwana (Scleropages formosus), Guppy (Poecilia reticulata), Koi (Cyprinus carpio), Betta (cupang), and Rainbow (Melanonotae-nia sp.) because they have high economic values and the best sales value in the market (Hyuha *et al.*, 2018). Betta fish is known as a fighter-type freshwater ornamental fish that has beautiful body color and fins. That advantage makes Betta Fish has a high selling point and can specifically be presented in national and international contests.

In Betta Fish cultivation, there are several things that need special attention, including water quality and feed quality (Shahjahan *et al.*, 2022). Quality assurance to improve water and feed quality needs to be done. A specific problem found in the quality of water for Betta Fish cultivation is the high content of dissolved particles and pH that can kill the fish. The cause of this problem can be influenced by several factors such as: chemicals, aquatic plants, and organisms. Excessive feeding can also reduce the quality of water (Raj *et al.*, 2020). Water quality is measured by several factors such as solute particles, DO, pH, salinity, temperature, turbidity, water level, and nitrogen compounds (Kusrini *et al.*, 2015).

Management of water quality for Betta Fish cultivation is very necessary to increase aquaculture production (Shahjahan *et al.*, 2022). Too low and too high water quality can affect the level of health as well as the production of aquatic life. This can cause fish to become stressed, increase disease susceptibility, reduce production levels, and cause death. Therefore, water quality management must be monitored in real-time because of its properties that can change quickly in a matter of hours (Lukito and Lukito, 2022). Real-time water quality management can be done based on automation technology. In the future, automation and Internet of Things (IoT) technologies can be integrated to control and monitor water quality management to optimize aquaculture. Several previous studies have successfully implemented IoT in aquaculture. Tamim et al (Tamim *et al.*, 2022), succeeded in developing an IoT-based fish monitoring system. Several parameters were implemented to obtain a better living environment for fish. Usha et al. (Kiruthika and Raja, 2017), created an embedded system as an automatic control of fish farming to save the time, cost and energy of the cultivators. Junaedi *et al.* (Junaedi and Ki, 2022), developed an IoT-based smart aquarium to facilitate the activities of aquarium ornamental fish hobbyists. There are several sensors implemented in his research to build a smart aquarium. Dener *et al.* (Dener, 2017), implemented IoT using the LM35 sensor to measure temperature in aquaponics with an operating temperature range of -550 to 1500 C, and water level to measure the height of the water tank with a distance of 40mm x 60mm. Abinaya *et al*. (Abinaya *et al.*, 2019) built an automated feeding system connected to Blynk using an ultrasonic sensor WiFi network HCSR04 used to calculate the feeding distance and LM35 to measure the temperature in the tank.

IoT and automation systems can be integrated in water and feed quality management in aquaculture. In this study, IoT is implemented for water and feed quality control and monitoring systems in Betta Fish cultivation. Several water samples were tested in this study, namely PDAM water, Methylene Bluewater, and Terminalia Catappa L. (TCL) water. The three water samples were tested with the parameters of dissolved solid substances (TDS), pH, and water level so that the error value of dissolved solid particles in the test water could be determined.

## SMART AQUARIUM FOR BETTA FISH CULTIVATION

### Water Quality Test

In this study, there were three parameters for testing water quality: total dissolved solids (TDS), pH, and water level.

#### a. Dissolved Solids

TDS is the total dissolved solids in water per million (Shahjahan *et al.*, 2022). In natural water, there are CO2 substances that can cause corrosion, while calcium, sulphate, nitrate, and nitrite cannot be removed by heating (Lukito and Lukito, 2022). If the TDS content of the water is high, it will have detrimental effects including sedimentation and corrosion (Rosenfeld and Lee, 2022). High dissolved content will also cause fish to die and decrease water PH, which causes stressful hypercapnia conditions for fish (Zamzari, Kassim and Yusoff, 2021).

#### b. pH Water

pH is an index of the concentration of hydrogen ions ([H +]) in water (Kassim *et al.*, 2021). The pH level of water is shown to determine how acidic or basic a solution is, with a value of less than 7 indicating acid while pH greater than 7 indicating base. Most common waters have a pH value between 6-9. The high or low degree of acidity or pH can be affected by temperature, DO, alkalinity, content of cations and anions, as well as organisms. The pH required in betta fish cultivation is 6.5-7 (Dener, 2017)

#### c. Water Level

Water level is a sensor that functions to detect the water level with an analog output which is then processed using a microcontroller. This sensor works by reading of the resistance generated by the water hitting the plate line on the sensor.

### Feed Quality Test

Provision of good feed for Betta Fish during the cultivation process in the aquarium is carried out 2-3 times a day, which is in the morning, afternoon and evening as much as 3 to 4% of the total weight of the fish. The rate of feeding as much as 6% is equivalent to 1.04 grams in the form of natural feed such as mosquito larvae gives the best results on the growth of betta fish seeds (Betta splendens). The results of feeding using different feed weight levels will show differences in fish growth. The consequences that arise if pH parameters, water quality, and feeding are not carried out properly are sudden death to fish, as well as diseases such as infections.

## METHODOLOGY

The system for controlling water quality and feeding in betta fish farming is illustrated in Figure-1. This system begins with analyzing and identifying water quality parameters in aquarium water for betta ornamental fish. The parameters analyzed were pH, TDS, and water level. To get the desired results, this investigation uses 3 sensors. pH 4520 C to measure the acidity of pool water, total dissolved solid sensor to measure the hardness of pool water, and ultrasonic HCSR04 as a sensor that detects pool water level. Data from sensors will be displayed via the LCD and the Blynk application with a data sending system using the internet.

The control and monitoring system built in this study used Arduino UNO as the main controller connected to the control unit. The control unit was adjusted to the water quality testing parameters. The three control units implemented in this system are Total Dissolved Solid (TDS) sensor to measure pond water hardness; a pH 4520 sensor in charge of measuring pool water acidity parameters; and an ultrasonic HCSR04 sensor that detects pool water level. In addition, Arduino is also connected to actuator units such as DC pumps, as well as servos. The system data flow is shown in Figure-1. The system architecture is shown in Figure-2.

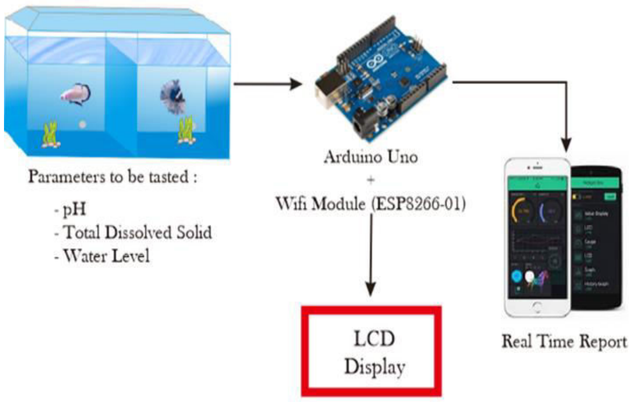


**Figure-1.** Data flow diagram of water quality control system.

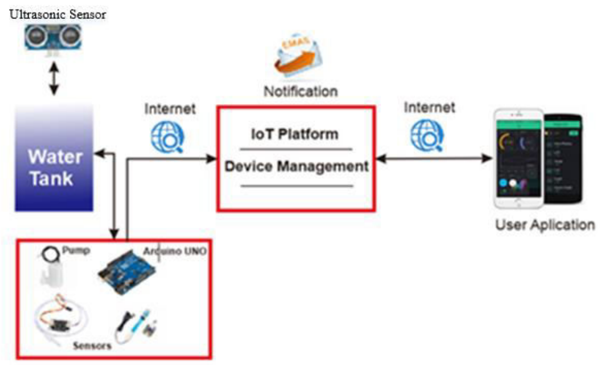


**Figure-2.** Architecture smart aquarium.

Figure-2 presents the Betta Fish cultivation control and monitoring system showing three sensors as inputs connected to Arduino. The sensor consists of pH, TDS, and ultrasonic sensors that will be installed in fish ponds or water tanks. The system is also connected to the

ESP8266 module as a serial communication. With this module, sensor data can be easily sent immediately to the cloud via wireless networks so that users can easily monitor the sensor readings.

Besides controlling and monitoring the quality of feed and water, this research has also developed integrated control systems. The controlled systems were water draining system and feeding system. System flowchart details are presented in Figure-3. In the dewatering system presented in Figure-3, the Arduino UNO controls the relay as a switch in filling and discharging water. The system begins by analyzing the sensors of the three water testing sensors, namely the TDS sensor; Ph sensor; and water level sensors.

The TDS sensor is used to detect the high or low content of dissolved particles in the pool water. The set point on the TDS sensor is 210 ppm with readings every 5 seconds. If the measured value exceeds < 210 ppm, then the water does not need to be drained.

The pH sensor is used to detect the acidity of pond water. The set point on the pH sensor is 7. If the pH sensor value is in the range of 6 - 7.5, then the water does not need to be drained. Water will be drained if the reading is in two conditions, namely > 210 ppm and pH > 7.

The ultrasonic sensor is used for water level controlling which is carried out in an aquarium size 15x16x16 cm. The water filling limit is 14 cm high and the lower limit is 5 cm high. The ppm, pH and water level can be stored in the blynk cloud database in the form of a CSV file.

In the feeding system, the Arduino UNO module is connected with a servo to open and close the fish feeder. Set point values for timing and servo rotation is determined. The servo is connected to Arduino where both feeding times have been set earlier in the program with the help of RTC (real time clock) to record, store and calculate the time. This feeding is carried out every 08.00 am and 05.00 pm. The working process is that when the RTC reads that the time has shown 08.00 am seconds 01 and 05.00 pm seconds 01, then the RTC will send a signal to the servo to open the feeder hole automatically. It will open for 1 second with a rotation of 90 degrees. The result of the time reading will be displayed on the LCD. Then the results will be reprocessed by Arduino and sent to ESP8266. ESP8266 will send the measurement results using a wireless network to the Blynk application installed on Android. By using the Blynk application, users can remotely give end-to-end commands to the system and can monitor it remotely.

After designing a water and feed quality monitoring system, namely making a body design. This system uses a glass aquarium with a glass thickness of 5 mm, length 15 cm x width 16 cm x height 16 cm. The betta fish used for this study were adult betta fish aged 16 - 20 weeks with an average fish length of 1.5 inches. The main components of the monitoring system include Arduino UNO, RTC DS3232, TDS sensor module, pH sensor module, ultrasonic sensor module, relay and display, and the ESP8266 module.

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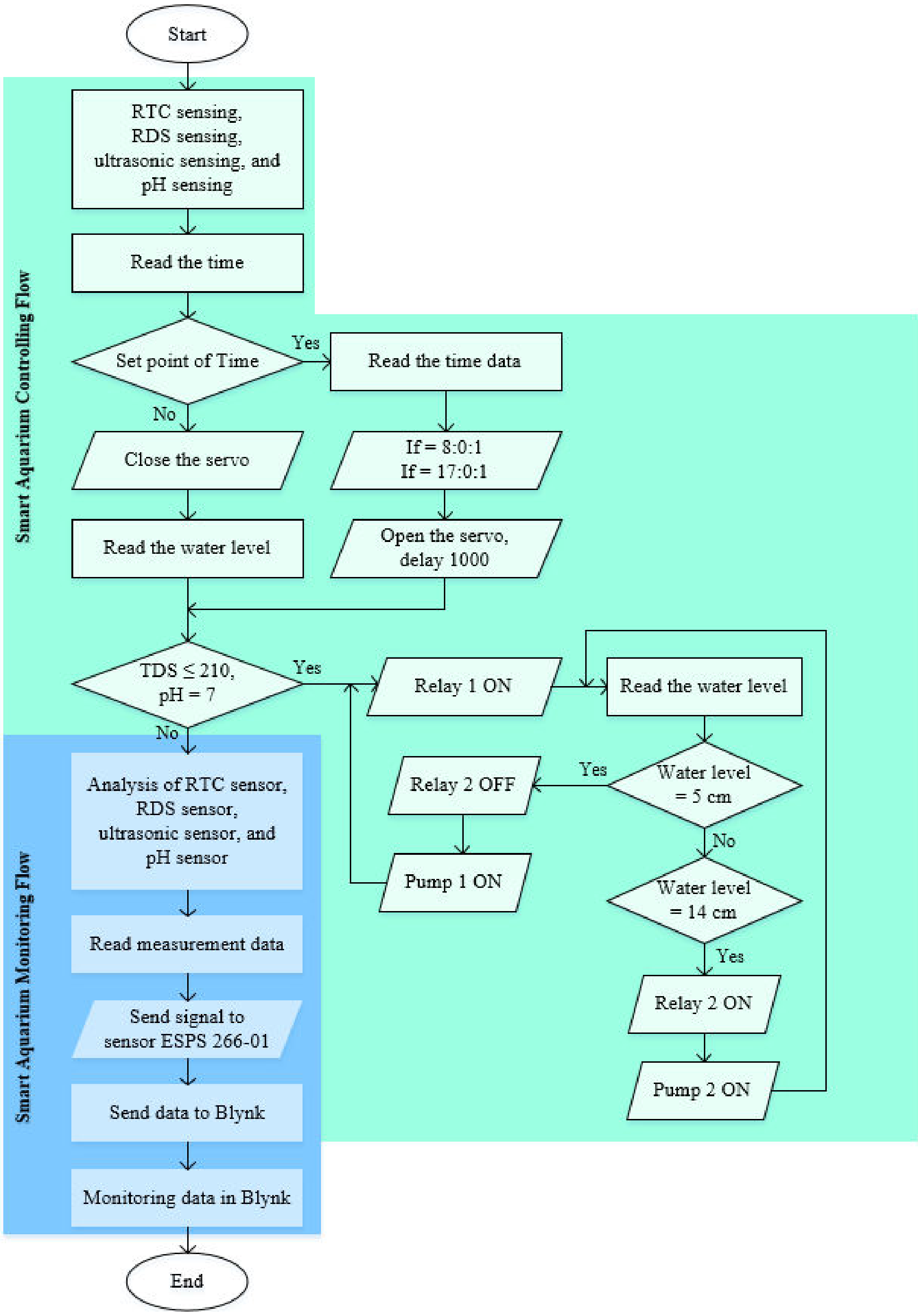


**Figure-3.** Flowchart of monitoring and control system.

## DISCUSSIONS

The research monitored water quality of TDS, pH, and water levels by integrating with the Blynk application to monitor parameter values. The measured data from the sensor would be displayed and stored by the Blynk cloud. The results stored by the Blynk cloud are presented in Figure-4.

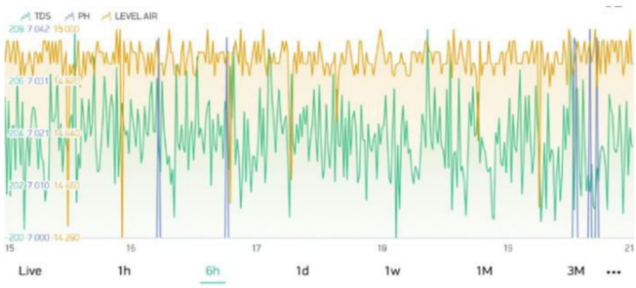


**Figure-4.** TDS, PH, and water level elevation parameters on Blynk.

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The data that had been measured by the sensor would then be stored by Blynk in the Blynk database in CSV format. The data could be downloaded via email that had been registered at the time the Blynk account was created.

Figure-5 shows the comparative data between the sensor values measured by the EC-TDS meter by reading at a water depth of 2 cm from the surface and gravity TDS reading at a depth of 13 cm from the surface on PDAM water. The results indicated that TDS levels were unsafe and harmful for fish as the data distribution exceeded 210 ppm.

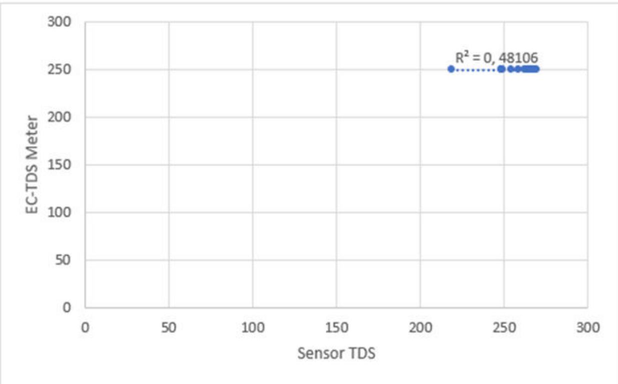


**Figure-5.** TDS results of PDAM water samples (TI).

Figure-6 shows the comparative data between sensor values measured by the EC-TDS meter by reading at a water depth of 2 cm from the surface and gravity TDS reading at a depth of 13 cm from the surface in Methylene Blue water. The results showed that the TDS level was within safe limits and not harmful to fish.

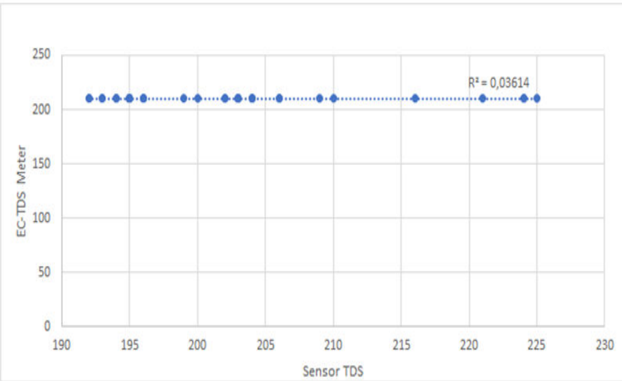


**Figure-6.** TDS results of methylene blue water sample (T2).

Figure-7 shows the comparative data between the sensor values measured by the EC-TDS meter by reading at a water depth of 2 cm from the surface and gravity TDS reading at a depth of 13 cm from the surface on TCL water. The results showed that TDS levels were at safe levels and not harmful to fish, as the data distribution values were below 210 ppm and above 185 ppm.

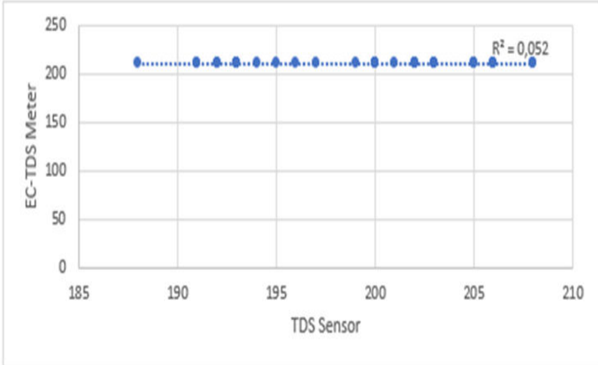


**Figure-7.** TDS results of TCL water samples (T3).

Figure-8 shows the comparative data between the sensor values measured by the pH sensor 4520 C and universal test paper on the solutions.

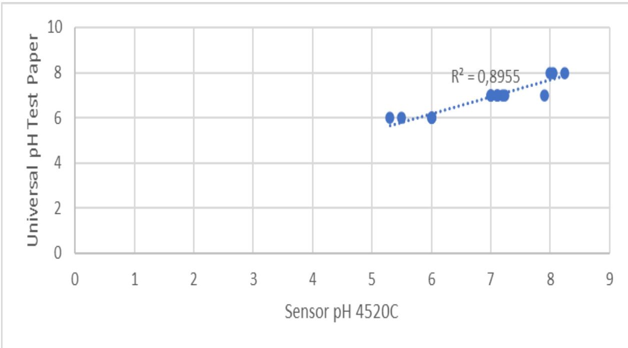


**Figure-8.** pH Sensor and universal pH test paper test chart.

During the test, it was found that the pH sensor was very sensitive compared to other sensors. There was a sudden change in pH compared to the actual reading with reference to the universal value of test paper. Figure-14 shows the comparison of water level measurement in aquarium water a size of 15 cm x 15 cm x 16 cm. The data showed that the water was at a safe level for betta fish.

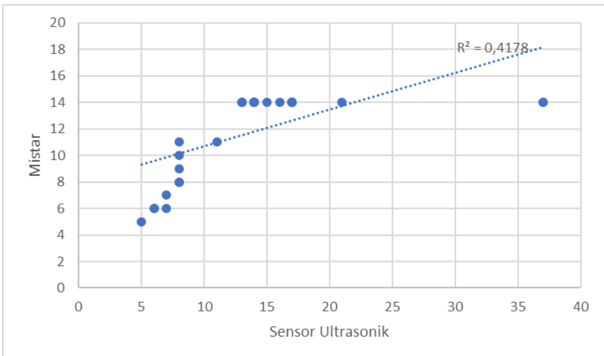


**Figure-9.** Ultrasonic sensor testing graph with ruler.

The results of observations of feed quality are presented in Table-1. The data showed that the servo was operating on time in providing feed within 1 week. The feed was given sufficiently for the needs of adult betta fish with an age of 16 weeks - 20 weeks and the average fish length was 1.5 inches.

**Table-1.** Observation results of servo performance and feed dispenses.

| No. | Trial | Feed dispenses | Servo (450) |
|---|---|---|---|
| 1 | 1 | Medium (7-8 grains) | OK |
| 2 | 2 | Medium (7-8 grains) | OK |
| 3 | 3 | Medium (7-8 grains) | OK |
| 4 | 4 | Medium (7-8 grains) | OK |
| 5 | 5 | Medium (7-8 grains) | OK |
| 6 | 6 | Medium (7-8 grains) | OK |
| 7 | 7 | Medium (7-8 grains) | OK |

## CONCLUSIONS

Based on the tests that had been carried out, there are several conclusions which are that the system worked properly according to what had been planned by the researchers so that this tool could be used appropriately by Betta ornamental fish cultivators to facilitate in managing water quality and feeding. Based on the results obtained from the tests on the three treatments, the T1 coefficient of determination was 0.48106, T2 coefficient of determination was 0.03614, and T3 coefficient of determination was 0.0519.

Furthermore, based on the results of the feeding test, the system could provide sufficient feed for the betta fish, which could dispense 7-8 pellets. So, it can be concluded that the entire system can be used to maintain good water quality. If the water quality is good, then the productivity of betta ornamental fish will also increase.

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